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# New and Historical Plant Introductions, and Potential Pests in the Juan Fernández Islands, Chile[1]

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ABSTRACT: In 1935 the Juan Fernández Islands in the Pacific Ocean were declared a Chilean National Park to protect the unique flora and fauna, and later given status as a Biosphere Reserve by IUCN. Exotic plants deliberately and inadvertently introduced are threats to the natural vegetation. We review the introduced and/or adventitious flora of the archipelago in this paper. We report 21 recent arrivals, eight earlier introductions from the mid-1700s to the 1900s that have not been recognized before in the flora, six misidentified taxa, and five taxa present earlier but now reported from another island, resulting in a total of 227 introduced and naturalized species. Each species is discussed briefly with its native distribution, uses, first arrival in Chile and/or the archipelago, and comments on conservation impact. Identities of some previously cited taxa are clarified (e.g., *Cupressus macrocarpa* appears to be a misidentification for two other species of the same genus). Other noxious weeds known worldwide have recently been deliberately introduced, especially as garden ornamentals. Two of the most serious potential pests are the bird-dispersed *Lantana camara* and *Lonicera japonica.* We recommend immediate eradication of these two taxa and restriction on reintroduction. A conservation program emphasizing strong physical and biological methods is urgently needed to control the introduced species.

IN GENERAL, OCEANIC ISLANDS have suffered a great deal from human impact including slash-and-burn agriculture, shipbuilding, logging, and from grazing and predation of feral animals, rabbits, rats, and other introduced mammals. Because natural vegetation on oceanic islands is often fragile, both deliberately and inadvertently introduced plants may become serious weeds. These in turn may threaten the native flora. In this paper we identify introduced plant species in the Juan Fernández Islands and assess their threat to native vegetation. Most of these taxa were discovered during the last expedition to Masatierra in January 1996, but research on the flora has involved seven expeditions over 16 years by a collaborating team from Ohio State University and Universidad de Concepción, Chile.

The Juan Fernández Islands lie about 650 km west of continental Chile in the Pacific Ocean and are composed of a chain of submarine volcanoes (González-Ferrán 1987, 1995), two of which rise above the sea forming Masafuera (33° 45′ S, 80° 46′ W) and Masatierra (33° 37′ S, 78° 50′ W), with the small island Santa Clara just 1 km southwest of the latter (Castilla and Oliva 1987). We use the names Masatierra and Masafuera, which are commonly used in English literature, but the islands are officially known in Spanish as Isla Robinson Crusoe and Isla Alejandro Selkirk, respectively. Radiometric dating has revealed that Masatierra is 3.8–4.2 million years old, and Masafuera is only 1.0–2.4 million years old (Stuessy et al. 1984). The two

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main islands total 98 km$^2$ in area, almost equally distributed between the two (Stuessy 1995). Because of their volcanic origin, the topography of the Islands is extremely rough, with step mountainsides, canyons, and valleys. The less-eroded Masafuera has an extremely rugged and inaccessible west side, with literally vertical mountain walls of almost 900 m. The highest peak on Masafuera (Los Inocentes) is 1319 m, and that on Masatierra is 916 m (El Yunque). To protect the unique flora and fauna, the Juan Fernández Islands were declared a national park in 1935 (Castilla and Oliva 1987) and later a Biosphere Reserve by the International Union for Conservation of Nature and Natural Resources (IUCN) (Stuessy 1995).

Skottsberg (1953) published careful data on the climatic conditions. A subtropical climate prevails, and on Masatierra summer and winter temperatures are, respectively, between 15 and 22°C and 9 and 15°C. Annual mean temperature is close to 15°C. The main rainy season is from May through August, with a total annual precipitation of about 900 mm. As the altitude rises, rainfall increases and temperature decreases. The archipelago is influenced by southeast trade winds, which prevail from the south to the west. On the two main islands, the highest peaks or ridges are frequently swept by clouds, but the low southwestern part of Masatierra and Santa Clara are dry (Stuessy 1995).

The most important work on natural plant communities in the Juan Fernández Islands was published by Skottsberg (1953). His principal groups of natural vegetation were evergreen dicotyledonous forest, evergreen brushwood and shrub, grasslands, and vegetation along waterfalls and streams and along the coastline. The first three habitats are, to different degrees, threatened by human impact and exotic plant introductions (Stuessy et al. 1997). There are 209 extant native flowering plants and ferns, and about 125 of those are endemic. Thus, species and generic endemism of the vascular plant flora is considered high and reaches about 60% and 11%, respectively (Stuessy et al. 1992). The endemic, monotypic paleoherb family Lactoridaceae is restricted to the high ridges of Masatierra (e.g., Crawford et al. 1994). Some of the endemic genera are *Centaurodendron* Johow, *Dendroseris* D. Don, *Robinsonia* DC., and *Yunquea* Skottsb., all in the Asteraceae and in extreme need of conservation (Bremer 1994, Stuessy et al. 1997). Furthermore, no less than 21 endemic species have a total population of fewer than 25 individuals (Stuessy et al., unpubl. data).

On the Juan Fernández Islands, many ecological changes have occurred as a result of human intervention since the archipelago was discovered in 1574 by Juan Fernández. Trees have been cut for rebuilding ships, construction of homes, and sale as firewood to steam-powered vessels (Woodward 1969). Hundreds, perhaps thousands, of individuals of the "cabbage-tree," the endemic palm *Juania australis* (Mart.) Drude ex Hook. f., were cut down for food (Wester 1991). The endemic sandalwood, *Santalum fernandezianum* F. Phil., was brought to extinction by cutting of the aromatic wood for sale to oriental markets. The last individual of the species was reported on Masatierra by Skottsberg (1910). Fires caused by human carelessness have also been a negative factor on the native flora (for example, the recent fire on Masafuera accidentally set by fishermen [Barriá 1996]).

The impact of exotic plants on the natural vegetation of the Juan Fernández Islands has been immense. The first report of the flora was compiled by Hemsley (1884). Twelve years later, in 1896, Johow published the first complete flora of the archipelago. Johow's flora is a useful source for early introductions, with careful notes on naturalized weeds, fruit trees, vegetables, grains, and ornamentals. In addition to already well-established species, Johow (1896) listed no fewer than 74 introduced cultivars. Some of them had already become serious weeds, like *Ugni molinae* Turcz.; others are being reported here for the first time as escaped, for example *Eucalyptus globulus* Labill.; and yet others are still restricted to gardens or may no longer be present on the Islands. Skottsberg (1921, 1951) listed (with the exception of cash crops) a total of 136 exotic species with notes on location, abundance, and origin. Later, Matthei et al. (1993) compiled a paper on the botanical history of the Juan Fernández Islands and included a complete, annotated list of adventitious species. They pointed out that, since the first botanical expeditions in 1823 by Mary Graham to Masa-

tierra, the total number of introduced species has averaged approximately one species per year.

Species with fleshy fruits are frequently bird-dispersed and, if weedy, they are the most potentially dangerous (Smith 1989). On the Juan Fernández Islands, the three most noxious weeds currently are *Aristotelia chilensis* (Molina) Stuntz, *Rubus ulmifolius* Schott, and *Ugni molinae,* all with fleshy fruits. The most efficient dispersal agent present on the Islands is probably the thrush, *Turdus falklandii* Quoy & Gaimard (Brooke 1987; U.S., pers. obs.). Torres and Aguayo (1971) recognized this bird as being deliberately introduced to the Islands, but Schlatter (1987) believed it may have dispersed there naturally in recent times. In any event, the three weeds referred to above have dramatically extended their distribution during the past 60 yr or so, altering the floristic composition and posing an immediate threat to the endemic flora (Sanders et al. 1982).

## NEW NATURALIZED SPECIES

New plant introductions to the Juan Fernández Islands are listed below. Our criteria for a "new introduction" are as follows. Deliberately introduced species such as ornamentals and crops must be found escaped from gardens and growing in isolation. Species that were planted in dense stands to help stabilize soil must have become naturalized, set seeds and seedlings, and become a permanent part of the landscape. Inadvertently introduced species that have no direct economic use, often dispersed on cargo, clothing, shoes, or camping gear, must be growing successfully in the archipelago. The term "weed" is used mainly for plants adapted to disturbed habitats and which may be ecologically aggressive. Weeds also occur naturally in every flora (i.e., native weeds), but most weeds that cause problems in natural vegetation are introduced alien species.

The species below are ordered alphabetically, with author, plant family, and island(s) from which they have been reported. For each species a brief discussion follows. When possible we have included English common name, geographical origin, first report for Chile, possible reason(s) why a particular species was introduced, and brief assessment on conservation management. In some cases, two closely related taxa are present or have been identified erroneously. In these cases, key characters are given for distinguishing them. Specimens that document the observed reports are cited from herbaria (CONC, OS, and UPS). This material was collected mainly during expeditions from 1980 to 1996.

Assessment of the impact an introduced species may have on the natural vegetation, especially without careful ecological studies, is difficult (Smith 1985, Cuddihy and Stone 1990, Groves and Di Castri 1991). Nonetheless, one can examine the impact of a species introduced elsewhere, record how much it has invaded into the natural vegetation, and suggest whether a weed is a potential pest, a threat, or just a harmless addition to the flora. The ecological impact the reported introductions to the Juan Fernández Islands may have on the natural vegetation is given in Table 1, along with geographical origin. In the Appendix, assessment of the threat to native vegetation is given for previously present exotic species from available field data, abundance, and literature (e.g., Skottsberg 1921, 1953, Sanders et al. 1982). Each species was scored by the following classification: (1) noxious, frequently invading natural vegetation; (2) serious threat, being close to or suspected to invade natural vegetation; (3) moderate threat, frequently observed and in many cases requiring control; and (4) status unclear, probably harmless. Our assessment is based on what harm each species may cause to the natural vegetation in the Juan Fernández archipelago, not to agriculture (cf. Matthei 1995).

*Apium australe* Thouars., Apiaceae, Masatierra. From Masatierra, Skottsberg (1921) reported *Apium chilense* and *A. graveolens,* two species also reported by Matthei et al. (1993). Available collections, however, all belong to *A. australe,* and we have not been able to confirm previous collections. The names *A. australe* and *A. chilense* may in fact be synonyms. *Apium australe* is native to South America in coastal, wet habitats and ordinarily is not recorded as a difficult weed. Specimens: Masatierra, San Juan Bautista, near the cemetery, 5 m, 25 November 1980, *Stuessy, Matthei, Sanders & Valdebenito 5443* (CONC, OS); same locality, 5 m, 19 January 1984, *Pacheco & Valdebenito 6270* (CONC, OS);

TABLE 1

REPORTED SPECIES INTRODUCED, MISIDENTIFIED, OR PRESUMPTIVELY NATIVE TO THE JUAN FERNÁNDEZ ISLANDS

| SPECIES | GEOGRAPHIC ORIGIN | TYPE OF WEED[a] | ISLAND[b] | YEAR OF FIRST COLLECTION OR CITATION[c] | REASON FOR AND COMMENTS ON INTRODUCTION |
|---|---|---|---|---|---|
| *Apium australe* | South America | 4 | MT | 1980 | Inadvertent, misidentified? |
| *Beta vulgaris* ssp. *maritima* | Europe | 4 | MT | 1996 | Inadvertent (?), recent arrival |
| *Bromus catharticus* | South America | 4 | MT, MF | Hemsley (1884) | Inadvertent, name change, not cited since 1921 |
| *Carpobrotus edulis* | Africa | 3 | MT, MF | P.O., 1986 | Garden, recent arrival |
| *Castanea sativa* | Europe, Asia | 4 | MT | Johow (1896) | Food, 1800s introduction |
| *Centranthus ruber* | Mediterranean | 4 | MT | 1996 | Garden, recent arrival |
| *Chenopodium sanctae-clarae* | Santa Clara endemic | 4 | MT | 1996 | Conservation, recent arrival |
| *Cupressus goveniana* | North America | 2 | MF | 1990 | Conservation, misidentified |
| *Cupressus macnabiana* | North America | 2 | MT, MF | 1996, 1986 | Conservation, misidentified |
| *Dactylis glomerata* | Europe | 2 | MT | 1996 | Garden, recent arrival |
| *Danthonia chilensis* var. *chilensis* | South America | 4 | MT | 1996 | Inadvertent, recent arrival |
| *Eucalyptus globulus* | Australia | 2 | MT, MF | Johow (1896) | Conservation, 1800s introduction |
| *Ficus carica* | Mediterranean | 4 | MT, MF | Johow (1896) | Food, 1800s introduction |
| *Fuchsia magellanica* | South America | 4 | MT | 1990 | Garden, recent arrival |
| *Galium aparine* | Europe | 3 | MT | 1996 | Inadvertent, known from Masafuera since 1921 |
| *Impatiens sodenii* | Africa | 4 | MT | 1996 | Garden, recent arrival |
| *Ipomoea indica* | Cosmopolitan | 1 | MT | 1990 | Garden, recent arrival |
| *Juncus bufonius* | Northern Hemisphere | 4 | MF | 1986 | Inadvertent, recent arrival |
| *Juncus capillaceus* | South America | 4 | MF | 1986 | Inadvertent, known from Masatierra since 1921 |
| *Lantana camara* | West Indies | 1 | MT | P.O. | Garden, recent arrrival, not yet naturalized |
| *Lavatera arborea* | Europe | 3 | MT | 1996 | Garden, recent arrival |
| *Lolium perenne* | Europe | 2 | MT | 1920 | Garden, early 1900s introduction |
| *Lonicera japonica* | Asia | 1 | MT | 1990 | Garden, recent arrival |
| *Madia sativa* | South America | 4 | MF | 1986 | Inadvertent, recent arrival |
| *Medicago arabica* | Mediterranean | 4 | MF | 1965 | Inadvertent (?), known from Masatierra since 1896 |
| *Mirabilis jalapa* | South America | 4 | MT | 1990 | Garden, recent arrival |
| *Myosotis laxa* | Eurasia | 4 | MT | 1990 | Garden (?), misidentified |
| *Myosotis sylvatica* | Eurasia | 3 | MT | 1980 | Garden, misidentified |
| *Paspalum dasypleurum* | South America | 4 | MT | 1980 | Inadvertent, recent arrival |
| *Pelargonium* × *asperum* | "Africa" | 4 | MT | 1980 | Garden, recent arrival |
| *Pinus radiata* | North America | 2 | MT | Johow (1896) | Conservation, 1800s introduction |
| *Prunus persica* | Asia | 4 | MF | Wester (1991) | Food, mid-1700s introduction |
| *Racosperma melanoxylon* | Australia | 2 | MT, MF | 1990, 1986 | Conservation, recent arrival |
| *Sambucus mexicana* | North America | 3 | MT | 1996 | Garden, recent arrival |
| *Setaria parviflora* | South America | 4 | MF | 1990 | Inadvertent, know from Masatierra since 1896 |
| *Solanum pseudocapsicum* | South America | 4 | MT | 1980 | Garden (?), recent arrival |
| *Spergularia rubra* | Europe | 3 | MT | 1996 | Inadvertent, recent arrival |
| *Trifolium dubium* | Europe | 3 | MF | 1965 | Inadvertent (?), misidentified |
| *Xanthium spinosum* | Northern Hemisphere | 3 | MF | Skottsberg (1921) | Inadvertent (?), known from Masatierra since 1921 |
| *Zantedeschia aethiopica* | Africa | 3 | MT, MF | Johow (1896) | Garden, 1800s introduction |

[a] Assessment of threat to native vegetation: (1) noxious, (2) serious, (3) moderate, (4) harmless.
[b] MT, Masatierra; MF, Masafuera; SC, Santa Clara.
[c] P.O., personal observation (no collection).

same locality, among rocks just above the sea, 23 January 1996, *Swenson, Baeza & Stuessy 462* (CONC, OS, UPS). San Juan Bautista, between the electric generating plant and the main street, 7 February 1990, *Rondanelli & Humaña 11498* (CONC, OS).

*Beta vulgaris* L. ssp. *maritima* (L.) Arcang., Chenopodiaceae, Masatierra. This subspecies of *Beta vulgaris* is the wild sea-beet native to the coastlines of Europe (Tutin et al. 1964), of which selected forms are cultivated as beetroot, mangold, and sugarbeet. It adds a new genus to the flora of the Juan Fernández Islands. The taxon may have been introduced as a food source or it might have self-dispersed from another source. It is known from the Pacific coast and, for example, was collected on Santa Catalina Island off California in 1965 and 1973 (*Hoefs & Propst 238, Thorne & Everett 34538,* respectively, RSA). The habitat noted for those collections is salt flats and scrub community from sea level to about 70 m, which corresponds to the habitat of the specimen collected on Masatierra. *Beta vulgaris* ssp. *maritima* may spread along the coast of the island but is not likely to be a threat to the native vegetation. Specimen: Masatierra, San Juan Bautista, near the cemetery, among rocks just above the sea as well as at the edge of the soccer field, 5 m, 23 January 1996, *Swenson, Baeza & Stuessy 460* (CONC, OS, UPS).

*Bromus catharticus* Vahl, Poaceae, Masatierra and Masafuera. This grass has long been present on Masatierra. It was noted already by Hemsley (1884) and later reported by Johow (1896) and Skottsberg (1921). The first specimen from Masafuera was collected by the latter author. At that time the species was known as *Bromus unioloides* (Willd.) Kunth. That name, however, is now in synonymy and the current name is *B. catharticus* (Matthei 1986). Although the nomenclatural issue seems clear, the species attracted our attention because it was not reported in recent publications on weeds and adventitious species growing in the Juan Fernández Archipelago and Chile (Matthei et al. 1993, Matthei 1995). *Bromus catharticus* is a South American weed but is widely spread around the world (Matthei 1995). It is found in lawns, along sidewalks, and on bare soil, but probably cannot be considered a serious weed outside those habitats. Specimen: Masatierra, San Juan Bautista, 10 m, 23 January 1996, *Swenson, Baeza & Stuessy 454* (CONC, OS, UPS).

*Carpobrotus edulis* (L.) N.E. Br., Aizoaceae, Masatierra and Masafuera. *Carpobrotus edulis* is known as hottentot fig because of its edible fruits (Mabberley 1987). It is a conspicuous, succulent plant, with large pinkish flowers, native to southern African coastlines. It was put into cultivation as an ornamental and to stabilize sand dunes (Hickman 1993). One often encounters it along highways, roads, and sidewalks. It has escaped from cultivation, can sometimes be quite invasive, and grows along the coasts of California, Mexico, and Chile (Hickman 1993). Hottentot fig is present on both Masatierra and Masafuera. Because it is difficult to dry succulent plants, collecting may have been avoided; thus, only one specimen has been collected, in 1986 on Masafuera. We also saw flowering individuals in January 1996 at the lighthouse on Masatierra. The large flowers of *C. edulis* add some color to the rocky coast of the Juan Fernández Islands, especially in San Juan Bautista, but its invasive tendencies must be remembered. It may pose a threat to other coastal species. However, the coastal flora is quite poor, and much of the coastline is either vertical or bare lava rocks, which should not be habitable for this species. Specimen: Masafuera, mouth of Quebrada Mono, 2 m, 7 February 1986, *Stuessy & Lammers 8329* (CONC, OS).

*Castanea sativa* L., Fagaceae, Masatierra. This species, chestnut, is native to the Mediterranean and Caucasus and has been in cultivation for a long time (Mabberley 1987). It is often introduced for its timber, as a garden ornamental, or for its highly appreciated seeds, a famous delicacy especially in Europe and the Canary Islands (Mabberley 1987; U. Swenson, pers. obs.). Chestnut was apperently deliberately introduced to Chile for its timber in the last century (Gay 1849). On Johow's expedition to Masatierra, several trees were observed that he called *Castanea vesca* (Johow 1896), now in synonymy with *C. sativa* (Hegi 1957). It is not known if Johow referred only to cultivated individuals. Today, several trees are still growing in various gardens throughout San Juan Bautista, but few trees seem to have escaped. Our specimen was collected in 1991 along a fencerow just up the hill behind the Corporación Nacional

Forestal (CONAF) cabin. It is not known if this particular tree originally was planted or if it actually has escaped from a garden. In any event, the species is introduced to the island, has the potential to become naturalized, and should be treated as an element of the flora. *Castanea sativa* can hardly be considered a troublesome species. It has been present for more than 100 yr and apparently has not extended its distribution. However, should it do so, simple cutting would be an effective way to restrict it. Specimen: Masatierra, San Juan Bautista, up from CONAF cabin, 140 m, 25 January 1991, *Stuessy & Crawford 12041* (CONC, OS).

*Centranthus ruber* (L.) DC., Valerianaceae, Masatierra. *Centranthus ruber,* red valerian, is a new introduction that adds a new genus and new family to the flora. On the expedition to Masatierra in 1996, we noted the species as an ornamental plant in several gardens but also naturalized along ditches in San Juan Bautista. Red valerian is native to the Mediterranean but also introduced elsewhere, such as New Zealand, Hawai'i, and California (Webb et al. 1988, Wagner et al. 1990, Hickman 1993). As a weed, it grows along roadsides, rock walls, and in disturbed places. It must have been introduced recently to Masatierra, has now escaped, and is beginning to spread. Possible future danger to the native flora is hard to assess. Specimen: Masatierra, San Juan Bautista, in a small ditch in center of village, 10 m, 17 January 1996, *Swenson 423* (CONC, OS, UPS).

*Chenopodium sanctae-clarae* Johow, Chenopodiaceae, Masatierra. *Chenopodium sanctae-clarae* was the only local endemic on the small island of Santa Clara. Bertero, who collected the species in 1895, observed the species more or less disappear from Santa Clara because of grazing pressure from goats and rabbits (Johow 1896). Today, its last refugium, Morro Spartán, is a small rock separated from Santa Clara by a narrow channel (Stuessy et al. 1992). A number of years ago, CONAF brought the species to Masatierra for cultivation and conservation. The project has been successful, and the species is growing extensively as an ornamental plant in San Juan Bautista. It is also used as a robust, easily shaped hedge. The species is now also recorded in disturbed areas as an escaped species in San Juan Bautista, but because it is a native element to the Juan Fernández Islands, it should not be regarded as a weed or pest. Specimen: Masatierra, San Juan Bautista, 35 m, 11 January 1996, *Swenson 360* (CONC, UPS).

*Cupressus goveniana* Gordon, Masatierra, and *Cupressus macnabiana* A. Murray, Masatierra and Masafuera, Cupressaceae. The systematics of *Cupressus* currently is unclear. The only introduced cypress to the Juan Fernández National Park was cited as *C. macrocarpa* (ciprés [Anonymous 1976]). The few specimens collected so far, however, do not belong to this taxon, and it is not clear if the reported species is present at all. The specimens collected belong to two other species, *Cupressus goveniana* (Gowen cypress) and *C. macnabiana* (McNab cypress), and were possibly introduced to the archipelago under the name *C. macrocarpa.* Both species are cultivated, planted, and naturalized. Both species are trees 7–10 m tall with a pyramidal shape. Branches of *C. macnabiana* are flattened and have a pungent scent of lemon when crushed from resin-covered glands on the outer leaf surface. The seeds are brown with a conspicuous attachment scar. In contrast, branches of *C. goveniana* are not flattened and lack strongly scented glands or pits, and the seeds are dark brown-blackish with an inconspicuous attachment scar (Hickman 1993). Both grow particularly well on eroded slopes, where they certainly prevent soil erosion. The ratio of the two species is not known, but the genus is successful, extending very far up the mountainsides. On Masatierra, we noted newly established populations on the ridge to Damajuana (400 m) at the margin of the evergreen forest. It is not known how ecologically aggressive the species may be, but they seem to be preadapted to eroded soils and may also penetrate into natural vegetation. Future studies of the vegetation must take this genus into consideration for further conservation measures. Specimens: *Cupressus goveniana:* Masatierra, San Juan Bautista, between El Castillo and the electric plant, 7 February 1990, *Stuessy & López 11450* (CONC, OS). *Cupressus macnabiana:* Masatierra, San Juan Bautista, 0–200 m, 17 January 1996, *Swenson 430* (CONC, OS, UPS). Masafuera, mouth of Quebrada Casas, 10 m, 11 February 1986, *Stuessy & Lammers 8444* (CONC, OS).

*Dactylis glomerata* L., Poaceae, Masatierra. The English name, orchard grass, possibly indicates why this species now also belongs to the flora of the Juan Fernández Islands. It has so far only been found on Masatierra, in San Juan Bautista, where it has been collected along the main cemented sidewalk in disturbed ground. We also noted several populations of *D. glomerata* near the power plant. *Dactylis glomerata* is a circumpolar species widely introduced in meadows, pasturelands, and lawns and is widely naturalized all over the world (Mabberley 1987). In Scandinavia, especially in Sweden where ecologically sensitive natural pasturelands are endangered, *D. glomerata* is a threat to those ecosystems where nitrogen has become superabundant. In those habitats, the grass is very successful and outcompetes a composition of other herbs created by long farming tradition (Ekstam and Forshed 1992, Söderström 1993). Apart from Europe, the species is found, for example, in southern South America, Hawai'i, and New Zealand (Moore 1983, Wagner et al. 1990). It was apparently present and naturalized on the subantarctic Snares, Campbell, and Auckland Islands before 1907 (Chilton 1909). On Hawai'i, where its presence has been known since 1909, it is no longer restricted to disturbed areas and has invaded different native subalpine communities (Wagner et al. 1990). *Dactylis glomerata* may need some special attention in the near future. The example from Hawai'i indicates what could happen on the Juan Fernández Islands. Several graminoids have been very invasive on the Islands, for example, *Anthoxanthum odoratum,* which now grows from sea level to the tops of the ridges (Sanders et al. 1982; U.S., pers. obs.). We suggest that *D. glomerata* needs to be strictly controlled before it begins to spread. Specimen: Masatierra, San Juan Bautista, 10 m, 11 January 1996, *Swenson 359* (UPS).

*Danthonia chilensis* E. Desv. var. *chilensis,* Poaceae, Masatierra. This variety of *D. chilensis* belongs to a complex of three varieties native to Argentina and Chile. It has a wide distribution, reaching from Valparaiso in the north to Chiloé in the south. *Danthonia chilensis* var. *chilensis* is the first variety recorded for the Juan Fernández Islands. It is found growing scattered along paths and is likely to have been introduced to Masatierra. Specimen: Masatierra, path to Mirador Selkirk from San Juan Bautista, 470 m, 14 January 1996, *Stuessy et al. 15023* (OS).

*Eucalyptus globulus* Labill., Myrtaceae, Masatierra and Masafuera. *Eucalyptus* is often widely introduced to tropical and subtropical countries around the world. For example, *Eucalyptus globulus* (Tasmanian bluegum), which we here report from the Juan Fernández Islands, was the first introduced species recorded as naturalized in New Zealand (Webb et al. 1988). Cultivation of *Eucalyptus* has multiple benefits: soil establishment, timber, or pulp, and the trees are frequently used for lumber, firewood, poles, and shade. *Eucalyptus globulus* was first introduced to the Juan Fernández Islands in 1884 (Johow 1896). On his expedition to Masatierra in 1892, Johow observed one plantation in which one tree had reached a height of 18 m in only 8 yr. *Eucalyptus globulus* was later mentioned by Skottsberg (1953) and, in the management plan for the national park, as an introduced species not causing any problems or damage to the natural vegetation (Anonymous 1976). Since then, we have not found it cited in the literature or species lists for the Islands. We believe, for reasons given below, that it is important once again to stress its presence on both Masatierra and Masafuera. *Eucalyptus globulus* grows naturally in continental Australia and Tasmania and may reach a height of about 70 m. On Masatierra (no data from Masafuera), we estimate trees to be 20–25 m tall. The species was planted initially to reforest steep, heavily eroded areas (Johow 1896) to control soil erosion. It is now well naturalized and seedlings establish easily, an observation also made on Hawai'i (Wagner et al. 1990). *Eucalyptus globulus* may have served a good purpose in the past by decreasing soil erosion, but it is aggressive. Two observations are noteworthy: (1) stands are often dense, resulting in a thick carpet of litter where literally no other plants can survive, and (2) it excludes other vegetation by allelopathy (Rice 1984). On the slopes above the village of San Juan Bautista, we observed that species of *Cupressus* and *Ugni* growing in the vicinity of *E. globulus* are dying. Specimens: Masatierra, San Juan Bautista, 7 February 1990, *Stuessy and López 11452* (CONC, OS); same locality, 10–150 m, 17 January 1996, *Swenson 421* (CONC, OS, UPS). Masafuera, mouth

of Quebrada Casas, 10 m, 11 February 1986, *Stuessy & Lammers 8437* (CONC, OS).

*Ficus carica* L., Moraceae, Masatierra and Masafuera. The edible fig, one of the most culturally used and well-known trees in the world, is a native of the Mediterranean region and it was cultivated by the Egyptians more than 6000 yr ago (Mabberley 1987). Today it is still an important cash crop in the Middle East; elsewhere it is widely cultivated as an ornamental or food source, having been introduced and naturalized in New Zealand, Hawai'i, and California (Webb et al. 1988, Wagner et al. 1990, Hickman 1993). *Ficus carica* must have been introduced to the Juan Fernández Islands in the early 1800s or possibly before that, because Johow (1896) recorded several vigorous, old groves in the 1890s, especially along the sea in the village of San Juan Bautista. He further mentioned that edible fig could be an excellent cash crop for export if the trees gave fruits that could be dried. What happened to those groves since those days is not known, but it is curious that neither Skottsberg (1921, 1951) nor any other authors cite the species again. In any event, *F. carica* is still present on both Masatierra and Masafuera; it is an exotic species and should be treated as such. Collections have been made in or near the villages of both islands. It is not known, however, if these trees originally were planted or escaped. The pollination biology of *Ficus* is an elaborate symbiosis between gall wasps and the plants, each species having its specialized insect (e.g., Barth 1985). A specific gall wasp is thus needed for successful fruit set and the subsequent spread of the species. In Hawai'i, the specific wasp for *F. carica, Blastophaga psenses* Gravenhorst, was introduced in 1909 but apparently the edible fig there still has not become naturalized (Wagner et al. 1990). It is not known if this wasp is present in the archipelago of Juan Fernández, but in any case the edible fig is unlikely to become a future plague in the Islands. Specimens: Masatierra, along the path between San Juan Bautista (El Palillo) and El Pangal, 4 m, 10 February 1990, *López & Peñilillo 11617* (CONC, OS). Masafuera, at mouth of Quebrada Casas, 3 m, 11 February 1986, *Stuessy & Lammers 8446* (CONC, OS).

*Fuchsia magellanica* Lam., Onagraceae, Masatierra. This is a shrubby species with attractive flowers of crimson red sepals and violet petals. *Fuchsia* is mainly restricted to Central and South America, with a few species in New Zealand and Tahiti (Berry 1982). The distribution of *F. magellanica* represents the most southern outpost of the genus, reaching Tierra del Fuego (Moore 1983). It is a hardy and popular shrub in gardens of the temperate region where it sometimes has also become naturalized (Mabberley 1987). For conservation purposes, it is unlikely that *F. magellanica* will be a serious pest in the future. It is native to continental South America, hardy, and hummingbird-pollinated. On Masatierra two native hummingbirds are present, *Sephanoides sephaniodes* Gray and the endemic *Sephanoides fernandensis* Gray (Colwell 1988). Pollination, fruit set, and subsequent establishment of the species may therefore be possible. Specimen: Masatierra, trail to Plazoleta el Yunque, 240 m, 24 January 1990, *T. & P. Stuessy, Crawford, Humaña & Baeza 11139* (OS).

*Galium aparine* L., Rubiaceae, Masatierra. This herb is an annual, scrambling European weed, extremely efficient in spreading itself by its bristled, hooked fruits. It is common in lawns, flower beds, fields, and disturbed areas. It is widely naturalized in many parts of the world, such as Bermuda, Canada, the United States, and New Zealand, and one of its many common names is goose grass (Britton and Brown 1913). *Galium aparine* apparently arrived in Chile even before the nineteenth century, because it was reported as a common herb from the north to the Magellan Sound by Clos (1847). It was first reported from Masafuera by Skottsberg (1921), but was not known from Masatierra until now. Specimen: Masatierra, San Juan Bautista, in lawn of CONAF garden, 50 m, 12 January 1996, *Swenson 393* (CONC, UPS).

*Impatiens sodenii* Engl., Balsaminaceae, Masatierra. *Impatiens* is a genus of about 850 species, widely distributed in the Tropics, especially in India and East Africa. Typical environments for *Impatiens* are submontane forests. A number of species have been brought into horticulture, improved by breeding, and hybridized. *Impatiens sodenii* is one of those, originally restricted to parts of the Eastern Arc Mountains of East Africa (Gray-Wilson 1980). It is now a famous garden plant and is sometimes found

naturalized (e.g., in New Zealand [Webb et al. 1988]). In San Juan Bautista, Masatierra, *I. sodenii* is commonly grown. The specimen there was found growing in a drainage ditch. Although it may spread in this type of habitat, this particular habitat is man-made and restricted on Masatierra, and it is not likely that it will become a severe weed on the island. Specimen: Masatierra, San Juan Bautista, 30 m, in a drainage ditch in front of Santa Bárbara fort, 17 January 1996, *Swenson 429* (UPS).

*Ipomoea indica* (Burm. f.) Merr., Convolvulaceae, Masatierra. The genus *Ipomoea* includes some 500 species distributed in the subtropics and Tropics. One group with large blue flowers and lanceolate sepals is commonly cultivated and often known as the morning glories. The systematics of this group, including *I. indica,* was sorted out by Fosberg (1976). For a comprehensive list of the species and synonyms for the New World, see Austin and Huáman (1996). *Ipomoea indica* is a twining herbaceous to somewhat woody vine with three-lobed or entire leaves. This species shares the same habit with two other noxious weeds, *Rubus ulmifolius* and *Lonicera japonica. Lonicera japonica* is reported here for the first time from Masatierra (see below), but *R. ulmifolius* was collected in 1927 (Looser 1927). This latter species has formed impenetrable thickets (Sanders et al. 1982) and obviously invades the evergreen dicotyledonous forest. Although *I. indica* is a pantropical weed, it was not reported by Johow (1896), Skottsberg (1921, 1951, 1953), or any subsequent author, and thus is not native to the archipelago. It is now abundant in San Juan Bautista, where it covers large patches of disturbed vegetation. We cannot assess with certainty how serious a threat this weed might be, but judging by the extent the species already has spread, we can only fear the worst. One advantage for conservation is that *I. indica* possesses no fleshy fruits and is thus not easily dispersed by birds. We hope that this weed remains restricted to San Juan Bautista. Specimen: Masatierra, San Juan Bautista, up the sidewalk toward El Castillo, 7 February 1990, *Stuessy & Baeza 11468* (CONC, OS).

*Juncus bufonius* L., Juncaceae, Masafuera. *Juncus bufonius* (toad rush) is an annual, low, weedy rush that prefers moist, bare soils. It can be recognized by its solitary flowers scattered in the upper part of the stem, forming a leafy, compound dichasial cyme. Matthei (1995) listed *J. bufonius* as a cosmopolitan species. Its original distribution, however, was probably much more restricted, and Wagner et al. (1990) reported it as North Africa, Eurasia, and North America. The first record from Chile was cited in Gay (1853). The collection made on Masafuera is unusual: among rocks and ferns on an outcrop at approximately 1300 m. Usually, *J. bufonius* is found in lower, disturbed areas, but in Hawai'i it has invaded natural grasslands up to 1500 m (Wagner et al. 1990). Specimen: Masafuera, up Cordón Inocentes from Las Tres Torres, 1250–1380 m, 5 February 1986, *Stuessy & Sepúlveda 9542* (CONC, OS).

*Juncus capillaceus* Lam., Juncaceae, Masafuera. This cespitose, perennial, erect, fairly small herb is native to central Chile and Ecuador and is also known from Masatierra (Skottsberg 1921). *Juncus capillaceus* is found in natural grasslands (often among rocks), in lawns, and in disturbed areas. All collections cited here were collected on Masafuera during the Juan Fernández Islands Expedition of 1986. *Juncus capillaceus* may be treated as a native weed. Specimens: Masafuera, Cerro Verde, 1000 m, 20 January 1986, *Stuessy & Doyle 9125* and *Landero & Gaete 9178* (CONC, OS); Plano de Rodríguez, 1090 m, 20 January 1986, *Valdebenito 9135* (CONC, OS); Quebrada Sánchez, 75 m, 9 February 1986, *Stuessy & Lammers 8387* (CONC, OS).

*Lantana camara* L., Verbenaceae, Masatierra. *Lantana camara* is a variable shrub, often armed, with flowers in capitate, hemispherical heads, often variously colored but frequently yellow, orange, or pink. It has a long array of different chromosome numbers (Wagner et al. 1990), which possibly make it extremely adaptable to different environments. The fruits are fleshy, black or purple, and dispersed by birds. The West Indies is probably the original distribution of *L. camara,* but it has now spread worldwide in subtropical and tropical areas (Wagner et al. 1990). It has become one of the world's most noxious weeds, causing much damage to native flora (e.g., in Australia and South Africa [Lawesson and Ortiz 1990]). It was introduced to Hawai'i in 1858, has now become naturalized,

and has invaded not only disturbed areas but also natural vegetation such as mesic forest and shrubland from almost sea level to about 1000 m. Biological control by introduction of various phytophagic insects to Hawai'i has not been successful in controlling the expansion of *L. camara* (Wagner et al. 1990). It has been listed among the 12 worst weeds in the Hawaiian Archipelago (Smith 1990). *Lantana camara* was also introduced to Floreana, Galápagos Islands, in 1938 (Cruz et al. 1986). There it forms dense, impenetrable thickets and has become a severe pest threatening both plants and animals. Once again, it has been listed as one of the most invasive alien plants (Lawesson 1990). *Lantana camara* was noted on Masatierra, San Juan Bautista, in a few gardens in January 1996. The species has not been recorded outside any garden, and thus no collection was made. However, we think it is important to mention its presence. It is an extremely noxious weed, sharing several characteristics with *Rubus ulmifolius,* for example, and probably has the potential to invade all types of evergreen forests. For conservation purposes this species should be eradicated from Masatierra and prohibited from being reintroduced.

*Lavatera arborea* L., Malvaceae, Masatierra. This species, the tree mallow, has red to purple flowers and a subwoody base. As the common name and the specific epithet imply, it is a fairly robust ornamental plant. It is native to Europe, introduced and naturalized in California, and for Chile was already reported as cultivated in gardens in the nineteenth century (Gay 1845). On Masatierra it is grown occasionally, especially in gardens along the main street. It has escaped in several places, such as near the cemetery. Its potential to spread outside the settlement is not known. Specimen: Masatierra, San Juan Bautista, near the cemetery, 10 m, 23 January 1996, *Swenson, Baeza & Stuessy 463* (CONC, OS, UPS).

*Lolium perenne* L., Poaceae, Masatierra. This grass, commonly known as perennial ryegrass, is native to Europe and has been introduced worldwide in temperate areas. This cespitose grass is used as fodder and in seed mixtures for lawns, playing fields, and soccer fields. It is easily naturalized and is a good survivor on well-trodden and compacted ground. *Lolium perenne* is another of the early grass arrivals to South America, first reported for Chile by Grisebach in 1854 and now widely distributed in the country (Matthei 1995). It arrived in the Juan Fernández Islands before 1920, when it was collected by William Alanson Bryan, former director of the Natural History Museum of Los Angeles County, in the "Colony, Juan Fernández Islands." Since that time, the species apparently has not been recollected. Matthei (1995) listed *Lolium perenne* as a common weed for Chile but not as a serious one. From our own experience, the species is often restricted to disturbed areas. It was reported from the remote subantarctic Snares and Campbell Islands as early as 1907 (Chilton 1909). On Hawai'i, where it was first collected in 1909, it is reported as naturalized in grasslands between 850 and 2440 m (Wagner et al. 1990). This may indicate that this taxon should be watched carefully. Specimens: Masatierra, "Colony," 29 March 1920, *Bryan s.n.* (OS); San Juan Bautista, on bare soil near the telephone call box, 10 m, 23 January 1996, *Swenson, Baeza & Stuessy 457* (CONC, OS, UPS).

*Lonicera japonica* Thunb., Caprifoliaceae, Masatierra. This Asian species, known by the common name Japanese honeysuckle, was described from Japan by Thunberg in 1784. It adds another genus to the flora of the Juan Fernández Islands and, together with *Sambucus mexicana* (see below), two representatives of the family Caprifoliaceae. The only known collection was made on Masatierra in 1990, but during the expedition in 1996, several specimens were noted in the settlement of San Juan Bautista. So far, the species has probably not escaped from the village into the national park. *Lonicera japonica* is a climbing or trailing vine, with a more or less woody base, opposite oblong-ovate leaves, axillary flowers in pairs, and a corolla 25–40 mm long with a pubescent tube. The species is an attractive garden plant and has been introduced to the United States and New Zealand. It prefers disturbed places and forest margins, and on several occasions, especially in the eastern United States, *L. japonica* is naturalized and has become a serious pest (Mabberley 1987). On Hawai'i, strains that set seeds have been reported (G. Linney, cited in Wagner et al. 1990), and it is feared that the species will become an extremely serious weed there. One of the most serious pests reported in the Juan Fernández Islands is *Rubus ulmifolius.* Some

characteristics of this weed are that it grows in disturbed habitats, is a trailing or scrambling woody herb, forms dark and dense stands that exclude other species, and was deliberately introduced. *Lonicera japonica* possesses most of these characteristics, and, as with *Rubus ulmifolius,* it has fleshy fruits dispersed by birds. It is not known if *L. japonica* sets seed on Masatierra. But if this is the case and it is allowed to reproduce freely, it most probably will become a troublesome weed invading evergreen forests. To assess its potential threat to the native vegetation, an immediate survey of its ecology, fruit set, abundance, and its presence inside and outside gardens should be undertaken. Eradication of *L. japonica* from the island would not be inappropriate. Specimen: Masatierra, San Juan Bautista, up the sidewalk toward El Castillo, 7 February 1990, *Stuessy & Baeza 11477* (OS).

*Madia sativa* Molina, Asteraceae, Masafuera. Chilean or coast tarweed are the common names of *Madia sativa* (Wagner et al. 1990, Hickman 1993). It is a weedy, extremely viscose herb native throughout most of the Pacific coast of North and South America. It has become naturalized in New Zealand (Webb et al. 1988) and also in Hawai'i, where it is known from only one location, Haleakalā Crater on Maui, possibly naturally dispersed by birds (Wagner et al 1990). In the Juan Fernández Islands this taxon is not yet common and has been collected only once, from Masafuera. The collectors noted that there was "only one plant seen in grassland community near the sea." Specimen: Masafuera, Quebrada Varadero, 10 m, 14 February 1986, *Valdebenito, Lammers & Sepúlveda 8510* (OS).

*Medicago arabica* (L.) Hudson, Fabaceae, Masafuera. This is a weedy herb originally from the Mediterranean region commonly known as spotted burclover. For Chile, Clos (1846) listed it in his second volume of "Historia de Chile"; Johow (1896) recorded it from Masatierra, and it is here reported from Masafuera. Spotted burclover has been introduced elsewhere in the world and is naturalized and abundant in the United States, New Brunswick (Canada), and New Zealand (Wilbur 1963, Webb et al. 1988, Hickman 1993). It grows in disturbed, often agricultural areas and cannot be considered as a serious weed or threat to the natural vegetation in the archipelago. Specimen: Masafuera, Quebrada de la Colonia, 28 November 1965, *Muñoz & Sierra 7110* (CONC, OS).

*Mirabilis jalapa* L., Nyctaginaceae, Masatierra. *Mirabilis jalapa* is an erect perennial herb having conspicuous crimson red-purple or variously colored flowers 3–5 cm long, which is native to tropical America. The common names, four-o'clock or marvel of Peru (Wagner et al. 1990), indicate that *M. jalapa* is a much-appreciated garden plant. The plant is also used as a cosmetic powder in Japan, for tinting seaweed jellies and cakes in China, and for its medicinal properties (Mabberley 1987). It is frequently naturalized, having nowadays a pantropical distribution and growing primarily in dry sites (Wagner et al. 1990). The first report from continental Chile was made by Gay in 1849. It is not known how long the plant has been grown in gardens on Masatierra, but it seems to be well established. Specimen: Masatierra, San Juan Bautista, 7 February 1990, *Stuessy and Baeza 11484* (CONC, OS).

*Myosotis laxa* Lehm. and *M. sylvatica* Hoffm., Boraginaceae, Masatierra. The herbaceous genus *Myosotis* is known by its common name, forget-me-nots. Matthei et al. (1993) and Matthei (1995) reported two species from Masatierra, *M. arvensis* and *M. discolor.* During the expedition of 1996, two additional forget-me-not species, *M. laxa* and *M. sylvatica,* were found and collected, but the two species reported earlier from San Juan Bautista could not be found. Examination of the previously cited two specimens in CONC revealed these to be *M. sylvatica* (*Muñoz & Sierra* CONC 69719) and *M. laxa* (*López & Peñailillo* CONC 116644). The earlier reports of *M. arvensis* and *M. discolor,* therefore, should be disregarded. The two species *Myosotis laxa* and *M. sylvatica* are very easy to distinguish. Although both species have blue petals with a yellow five-appendaged eye, *M. laxa* has a 4-mm-wide corolla and appressed hairy calyx and always grows in moist habitats such as along brooks or stagnant water. In contrast, *M. sylvatica* has a wider corolla (ca. 8 mm) and a hooked and hispid-hairy calyx and grows on drier soils, often in shaded environments. The ecology of the latter species has made it a popular garden plant, and many forms including pink-flowered ones are cultivated (Mabberley 1987). Both species of *Myosotis* are native to the Northern Hemi-

sphere; *M. laxa* is possibly circumpolar and *M. sylvatica* is Eurasian (Lid 1985). For conservation purposes, *M. laxa* may never become extremely abundant, because it is restricted to moist habitats that are fairly scarce on the Juan Fernández Islands. *M. sylvatica,* however, is already a common weed in the village and probably will continue to spread in disturbed areas. As an herb, it is doubtful that it will have a major impact on the native flora, but it may penetrate into dry forest floors. Specimens: *Myosotis laxa:* Masatierra, San Juan Bautista, path to El Palillo, 7 February 1990, *Rondanelli & Humaña 11519* (CONC, OS); same locality, south of the cemetery, 7 February 1990, *López & Peñailillo 11560* (CONC, OS); same locality, on moist ground along a brook, 35 m, 11 January 1996, *Swenson 369* (CONC, OS, UPS). *Myosotis sylvatica:* Masatierra, path toward Mirador de Selkirk from San Juan Bautista, 300 m, 25 November 1980, *Stuessy, Matthei, Sanders & Valdebenito 5433* (CONC, OS); San Juan Bautista, near CONAF headquarters, 19 January 1984, *Pacheco & Valdebenito 6284* (OS); same locality, up the sidewalk toward El Castillo, 7 February 1990, *Stuessy & Baeza 11474* (OS); same locality, in upper part of village, 50 m, 11 January 1996, *Swenson 370* (CONC, UPS).

*Paspalum dasypleurum* Kunze ex E. Desv., Poaceae, Masatierra. This species is considered a native weed in southwestern Argentina and Chile (Nicora 1978, Matthei 1995), but it has not been reported before from the Juan Fernández Archipelago. The first specimen identified from Masatierra was collected during the Ohio State University–Universidad de Concepción expedition to the Islands in 1980. It is found in wet ravines, roadsides, and lawns and was probably inadvertently introduced to the island. Specimen: Masatierra, San Juan Bautista, Bahia Cumberland, 4 February 1980, *Marticorena & Ugarte 9100* (CONC, OS); same locality, 7 February 1990, *Rondanelli & Humaña 11508* (OS); same locality, 35 m, 11 January 1996, *Swenson 367* (CONC, OS, UPS).

*Pelargonium* × *asperum* Willd., Geraniaceae, Masatierra. According to Webb et al. (1988), *P.* × *asperum* is the most commonly cultivated hybrid occurring in the wild. The parents are *P. graveolens* and *P. radens;* on New Zealand it spreads only vegetatively because mature fruits are not observed, a case possibly true on Masatierra also. So far, plants have been recorded only near the cemetery and toward the sea in a few well-limited populations. We assess it as less harmful than many other introductions to the island. Specimens: Masatierra, San Juan Bautista, at the beach, 5 m, 25 November 1980, *Stuessy, Matthei, Sanders & Valdebenito 5437* (CONC, OS); Cumberland, cemetery, 19 January 1984, *Pacheco & Valdebenito 6268* (CONC, OS).

*Pinus radiata* D. Don, Pinaceae, Masatierra. This pine, known as Monterey or radiata pine, is native to the western United States. It is nowadays rare in the wild, but is planted extensively (e.g., in Chile and lowland New Zealand [Webb et al. 1988, Hickman 1993, Marticorena and Rodríguez 1995]). Furthermore, Webb et al. (1988) stated that it is the most imported timber tree and frequently used as shelter around settlements in New Zealand. Despite this, it does not seem to naturalize there very frequently. Radiata pine is another gymnosperm introduced to Masatierra that, for some reason, has not received much attention. The species was reported as *Pinus insignis* (= *P. radiata* [Webb et al. 1988]) from the archipelago by Johow in 1896. He had seen some small individuals and recommended the species for future extensive plantations. Subsequent cultivation has indeed taken place, and nowadays it is found in dense stands on eroded areas; some groves are estimated to be 40–50 yr old, having a height of almost 40 m. The trees have good seed set, and seedlings are abundant to an altitude of 150–200 m above San Juan Bautista. In contrast to New Zealand, *P. radiata* is very successful on Masatierra and continues to spread. Although this happens primarily in disturbed areas, we think that the species ought to be closely monitored and subsequent conservation measures taken. Specimens: Masatierra, San Juan Bautista, 10 m, 7 February 1990, *Stuessy & López 11451* (OS); same locality, up the track to the Mirador, 150 m, 21 January 1996, *Swenson 443* (OS, CONC, UPS).

*Prunus persica* (L.) Batsch, Rosaceae, Masafuera. We here report *P. persica* (peach) from Masafuera. According to Wester (1991), peach was already present on Masatierra in the 1740s, but most likely restricted to gardens. The next citation appears in Anonymous (1976), but this source is not readily available and we think it

is important to add this species to the list of introduced flora. It was further stated in Anonymous (1976) that *P. persica* should not constitute an immediate danger to the natural vegetation; most often species of *Prunus* may persist only near human settlements (Hickman 1993). *Prunus persica* is an important cash crop, native to China, introduced most probably for the valuable fruits. The specimen studied was collected in the bottom of the quebrada west of the settlement on Masafuera. It is not certain if this individual originally escaped or if it was planted. Specimen: Masafuera, Quebrada Casas, 10 m, 11 February 1986, *Stuessy & Lammers 8445* (CONC, OS).

*Racosperma melanoxylon* (R. Br.) C. Mart., Fabaceae, Masatierra and Masafuera. Matthei et al. (1993) reported *Acacia dealbata* (silver wattle) from Masatierra for the first time. This species is now transferred to *Racosperma* (Pedley 1986, 1987). We now report a second species from this genus, *R. melanoxylon* (Tasmanian blackwood), from both Masatierra and Masafuera. On the islands the two species are easy to distinguish, even in a sterile stage, because of their leaf morphology. *Racosperma dealbatum* possesses, as do most species in the genus, bipinnate leaves, whereas *R. melanoxylon* has bipinnate leaves only as juveniles. These leaves drop to the ground as juveniles and leave flattened, narrowly elliptic, often slightly curved phyllodes. Both species of *Racosperma* are native to Tasmania and eastern Australia. *Racosperma melanoxylon* has been introduced elsewhere (e.g., to Europe, New Zealand, and Hawai'i, where it frequently has become naturalized [Tutin et al. 1968, Webb et al. 1988, Wagner et al. 1990]). It is used in forestry, and because of its hard wood it is suitable for use in furniture, tools, and boat-building, and sometimes it is planted to slow soil erosion (Kunkel 1978, Webb et al. 1988). It is not known if either of these species may cause problems for the native vegetation of the Juan Fernández Islands. So far, they have not invaded the natural vegetation and are found only in heavily eroded areas. All collections referred to here were made in the vicinity of the settlements on both islands. For example, on Masatierra up the slope from the power plant, both species are abundant in that valley and do particularly well in wetter areas. Specimens: Masatierra, San Juan Bautista, between El Castillo and the electric generating plant, 7 February 1990, *Stuessy & López 11453* (CONC, OS); same locality, in the surroundings of the power plant, 50 m, 18 January 1996, *Swenson 448* (CONC, OS, UPS). Masafuera, village at mouth of Quebrada Casas, 10 m, 11 February 1986, *Stuessy and Lammers 8442* (CONC, OS).

*Sambucus mexicana* C. Presl, Caprifoliaceae, Masatierra. Mexican or blue elderberry are the common names of *S. mexicana.* It is a shrub or a tree that can reach almost 10 m in height. The natural distribution includes southern United States and Mexico, but it is also commonly cultivated throughout Latin America as well as in Hawai'i (Wagner et al. 1990). *Sambucus mexicana* is still another garden plant introduced to the Juan Fernández Islands that has now escaped from cultivation. The stand from which this specimen was collected in a drainage ditch in San Juan Bautista carried both juvenile and fruiting shoots. This shows that the species has escaped, has become naturalized, and is now reproducing regularly on the island. The species has probably been cultivated on Masatierra for some time, because one of the trees seen in a garden must be 30 yr old or more. Naturalized plants in Hawai'i and California occur in forest margins and wet areas, habitats similar to the locality on Masatierra (Wagner et al. 1990, Hickman 1993). It may escape farther away from San Juan Bautista, but it is unlikely to become an uncontrolled pest. Specimen: Masatierra, San Juan Bautista, in a drainage ditch near the house of Aeronaútica, 50 m, 17 January 1996, *Swenson 422* (CONC, UPS).

*Setaria parviflora* (Poiret) Kerguélen, Poaceae, Masafuera. This grass is native to South America (Matthei 1995) and is known from Masatierra since first reported by Johow in 1896. We now report it from Masafuera, where it still seems to be a scarce species, growing near the sea, and only one collection has so far been encountered. Specimen: Masafuera, between Quebrada Casas and Paso Malo, 5 m, 5 February 1990, *Baeza & Peñailillo 11431* (OS).

*Solanum pseudocapsicum* L., Solanaceae, Masatierra. Eight species of the diverse genus *Solanum* are represented in the Juan Fernández Islands. Four of them are endemic (Stuessy et al. 1990), and the other four are introduced, often

escaped from cultivation (Skottsberg 1921, Matthei et al. 1993). We now report *S. pseudocapsicum* (Jerusalem cherry) as a new introduction to the flora of Masatierra. *Solanum pseudocapsicum* is an unarmed, glabrous shrub up to 1.5 m tall, with elliptic leaves 5–8 cm long, white flowers 1 cm wide, and orange fruits. It is widely cultivated and distributed in the Tropics and was early introduced, probably before the 1870s, to the main islands of Hawai'i (Wagner et al. 1990). It is native to South America, possibly eastern Argentina, and has been present on Madeira since 1650 (Mabberley 1987). The species typically grows in disturbed sites, such as with *Rubus ulmifolius,* and was noted on several locations in the village. Its potential for being a serious weed is estimated as low. Specimens: Masatierra, Valle Anson, 15 m, 10 February 1980, *Marticorena & Ugarte 9197* (CONC, OS); near CONAF headquarters, 19 January 1984, *Pacheco & Valdebenito 6283* (CONC, OS); San Juan Bautista, 35 m, 11 January 1996, *Swenson 361* (CONC, UPS).

*Spergularia rubra* (L.) J. Presl & C. Presl, Caryophyllaceae, Masatierra. *Spergularia rubra* (sand spurrey) is a low, weedy herb, possessing needlelike leaves and pink flowers. It is a European weed, commonly naturalized in New Zealand and North and South America. The habitats are disturbed ground and gravelly or sandy soils, and it is often found along roads and sidewalks. It was reported from Chile as *Arenaria rubra* (Naudin 1845) and from Masatierra and Masafuera by Hemsley (1884) and Johow (1896). Specimens from the Juan Fernández Islands, however, were considered by Skottsberg (1921) as belonging to *Spergularia confertiflora* Steud. This is a native species growing on the bare lava cliffs near the sea, a habitat not conforming to that of *S. rubra.* The first record of *S. rubra* from Masatierra is now secured, collected on dry, sandy soil in the soccer field northwest of the plaza, San Juan Bautista. *Spergularia rubra* was cited as a principal weed distributed in central Chile by Matthei (1995). Its possible impact on the native flora in the archipelago is difficult to assess, but we believe that suitable habitats are restricted, and, thus, it is most likely not a noxious weed. Specimen: Masatierra, San Juan Bautista, on the soccer field, 10 m, 23 January 1996, *Swenson, Baeza & Stuessy 456* (CONC, OS, UPS).

*Trifolium dubium* Sibth., Fabaceae, Masafuera. Matthei et al. (1993) reported *T. campestre* from Masafuera, citing a collection made by *Muñoz and Sierra 7131* in 1965 (CONC). Reexamination of a duplicate (OS) revealed that it does not belong to *T. campestre* but instead to *T. dubium* (small hop-clover). The two yellow-flowered hop-clovers are difficult to separate from each other, but at least three characters are diagnostic. *Trifolium dubium* has 5–15 flowered heads, leaflets 0.5 cm long, and marginally hairy stipules. *Trifolium campestre,* on the other hand, has 20–40 flowered heads, leaflets about 1 cm long, and glabrous stipules. *Trifolium dubium* is native to Europe and is now widely naturalized around the world growing in pasturelands, along roadsides, and disturbed areas in general. It is now present in much of the continental United States, Hawai'i, Chile, and in Tierra del Fuego, where it may be abundant (Moore 1983, Wagner et al. 1990; U.S., pers. obs.). Matthei (1995) did not consider it as a serious weed, but rather as an occasional species in cultivation. In the archipelago, it is apparently a rare species and should not cause much harm to the native flora. Specimen: Masafuera, Quebrada del cementerio, 150 m, 29 November 1965, *Muñoz & Sierra 7131* (CONC, OS).

*Xanthium spinosum* L., Asteraceae, Masafuera. Skottsberg (1921) was the first to report *X. spinosum* (clotbur or bathurs bur) from the Juan Fernández Islands (Masatierra). It has now extended its distribution to Masafuera, where it was collected in 1986. *Xanthium spinosum* is an armed spiny Asteraceae. The involucral bracts of the female plant are fused (bur) and covered with hooked spines. It is a worldwide weed with an uncertain origin, possibly from Europe or Asia (Britton and Brown 1913; see Löve and Dansereau [1959] for more details). It grows frequently around human settlements, along roadsides, and around fruit orchards (Matthei 1995). Specimen: Masafuera, village at mouth of Quebrada Casas, 10 m, 11 February 1986, *Stuessy & Lammers 8435* (CONC, OS).

*Zantedeschia aethiopica* (L.) Spreng., Araceae, Masatierra and Masafuera. *Zantedeschia aethiopica* (calla lily) is native to South Africa. It was taken into cultivation early, introduced to

Europe by 1687 (Wagner et al. 1990), and became widely distributed and naturalized in Asia and North and South America. In Hawai'i it is known to have been in cultivation since the 1870s, but the first escaped specimen was collected only in 1986 (Wagner et al. 1990). Calla lily is another of the Juan Fernández Islands species that has been naturalized for more than 100 yr (Johow 1896), but is still not recognized as an element of the flora. It was probably introduced to Chile and then to the Juan Fernández Islands, but the exact year of introduction is not known. From our interpretation of Johow's report, the species seemed already well established in the 1800s, growing in various valleys. Today, *Z. aethiopica* is frequently grown in gardens of San Juan Bautista, used in floral arrangements, and well established outside the gardens, especially in moist habitats. It is frequently found in moist ravine bottoms in Masafuera. The potential for the species as a pest is limited to the few moist, man-made drainage areas on the Islands, where no endangered native species grows. Specimens: Masatierra, San Juan Bautista, Calle la Pólvora, 7 February 1990, *Stuessy & Baeza 11483* (CONC); same locality, 30 m, in a drainage ditch near the house of Aeronaútica, 17 January 1996, *Swenson 431* (UPS). Masafuera, Quebrada Casas, 10 m, 11 February 1986, *Stuessy & Lammers 8438* (CONC, OS).

## DISCUSSION

No fewer than 40 records are here reported as additional, naturalized plants in the Juan Fernández Islands; most appear as weeds distributed on Masatierra (33) and Masafuera (14). One exception, however, is the Santa Clara endemic *Chenopodium sanctae-clarae,* which was "introduced" to Masatierra for the purpose of conservation. The plants can be sorted into four categories: (1) recent arrivals, (2) introductions from the mid-1700s to the 1900s but hitherto not considered as naturalized, (3) misidentifications, and (4) species present earlier on either island, but now dispersed to the other (Table 1). These categories are represented by 21, 8, 6, and 5 species, respectively, and represent nine families (Cupressaceae, Pinaceae, Balsaminaceae, Caprifoliaceae, Fagaceae, Moraceae, Nyctaginaceae, Valerianaceae, Araceae) and 19 genera not reported earlier in the archipelago. The known introduced and naturalized flora is now 227 species. This figure exceeds the estimated 209 native and endemic species (Stuessy et al. 1992), giving a total vascular flora of 436 species, with weeds making up 52%.

The impact the introduced or adventitious vascular flora (Appendix) may have on the natural vegetation is hard to assess. We believe it is useful for conservation purposes to score every species, as mentioned earlier, between 1 and 4, with 1 categorizing the weed as a serious pest and 4 denoting a low threat to the native vegetation. For example, *Rumex acetosella* L. may seem to be a harmless herb, but it is scored as a noxious weed. Our field observations confirm that available undisturbed habitats such as cliff ledges, dry mountain ridges, and step hillsides are frequently dominated by this species. Thus, it is a successive intruder in native vegetation, but because of the lack of ecological studies it is not known whether it actually excludes any native species. Looking at extremely noxious (1) and serious threat (2) weeds, we find that all gymnosperms and 27 species of dicots pose a real threat to the natural vegetation (Figure 1). All these species are present on Masatierra, the more trafficked island with the permanent settlement San Juan Bautista. Fewer weeds that are serious threats are present on Masafuera, which is inhabited only 8 months per year during the lobster season. The bulk of the weeds on both islands are scored as of moderate threat, possibly in need of control (3). This group together with the category of harmless species (4) might be scored differently with more detailed knowledge of the ecology and distribution of the species on the Islands. In any event, fewer species in these two categories are present on Masafuera than on Masatierra. The rugged, dry island of Santa Clara, which probably has never had any extensive vegetation (e.g., Ringrose 1685), possesses only a fraction of the weedy flora. The most serious weedy species present there are *Avena barbata* Pott ex Link, *Rumex crispus* L., and *Silybum marianum* (L.) Gaertner. We believe that Santa Clara has suffered much more from feral animals than from introduced weeds (earlier cited as Goat Island [e.g., Prévost 1753]).

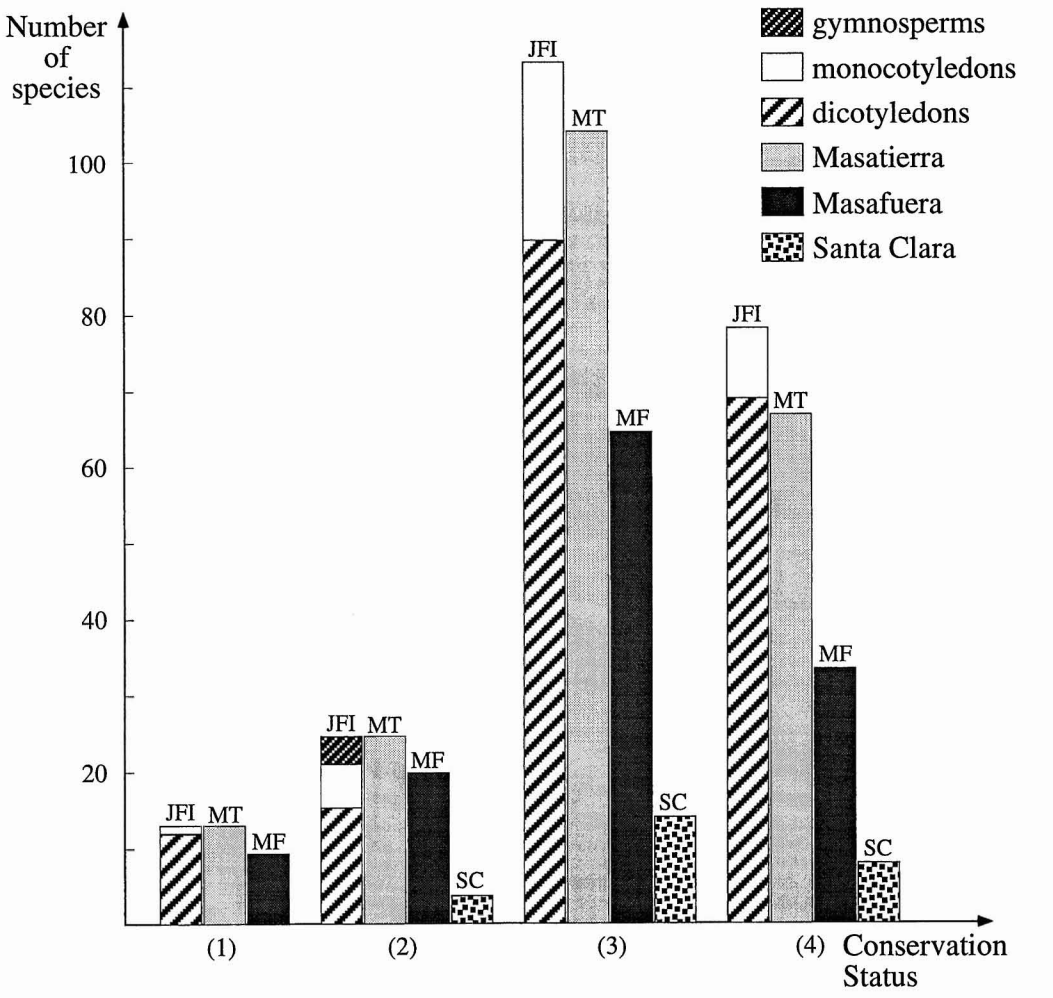


FIGURE 1. Number of introduced species in the Juan Fernández Islands (JFI) scored by their potential ability to invade natural vegetation: noxious (1), serious (2), moderate (3), and harmless (4). The left bar in each category shows the total number of gymnosperms, monocotyledons, and dicotyledons in the archipelago, and the other two or three bars show the total number of introduced species for each island.

The most noxious weeds present on the Islands are the bird-dispersed, woody species *Aristotelia chilensis, Rubus ulmifolius,* and *Ugni molinae.* To this group of weeds that are serious threats we add *Ipomoea indica, Lantana camara,* and *Lonicera japonica.* We stress that immediate ecological studies of these species are needed. We recommend that the two latter species be eradicated from the island and prohibited from being reintroduced. Other less-serious pests should also be kept under close observation (e.g., *Dactylis glomerata, Galium aparine, Lolium perenne, Racosperma melanoxylon,* and possibly *Spergularia rubra*).

Among the most noxious weeds are also some herbs. Sanders et al. (1982) described floristic changes of seven localities from Skottsberg's time in 1917 to their own expedition in 1980. They reported *Acaena argentea* Ruiz & Pavón and *Anthoxanthum odoratum* L. as being prolific. We confirm these observations and add to this group *Conium maculatum* L. and *Rumex acetosella.*

It is important both for forestry as well as

conservation that species newly arriving in an area be correctly identified, because they might cause much damage to natural vegetation in the future. For example, the alleged introduction of the gymnosperm *Cupressus macrocarpa* (Anonymous 1976) is most certainly an introduction of two other species, *C. goveniana* and *C. macnabiana,* two species now extending their range on Masatierra and possibly penetrating into native vegetation. Many of the early introductions have certainly prevented soil erosion (e.g., *Eucalyptus globulus* and *Pinus radiata*). These two are cultivated in dense stands, are well established, reproduce, and may represent future problems. Most certainly, these species must now be recognized as part of the flora.

We also learned from this study that exotic taxa introduced for forestry or conservation purposes, and especially ornamentals into gardens, are the species most likely to cause the most severe problems in later years. This indicates two things: (1) the biology of a species (i.e., its response to a new environment) must be studied and understood before it is released into a new environment; and (2) because garden ornamentals cannot be restricted to designated areas, introduction of such plants needs to be strictly controlled if the national park's commitments are to be fulfilled.

From a conservation standpoint, as with *Dendroseris litoralis,* we are delighted to report that *Chenopodium sanctae-clarae* is for the moment saved from extinction. It is an excellent example of how a local endemic species can be taken into cultivation and successfully propagated, planted, and maintained as an ornamental.

Finally, Sanders et al. (1982) urged international financial help for conservation programs to help save the unique flora of the Juan Fernández Islands. After more than a decade, we emphasize that the current need is even more urgent.

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## LITERATURE CITED

ANONYMOUS. 1976. Plan de manejo Parque Nacional Juan Fernández. Corporación Nacional Forestal (CONAF), Santiago, Chile.

AUSTIN, D. F., and Z. HUÁMAN. 1996. A synopsis of *Ipomoea* (Convolvulaceae) in the Americas. Taxon 45:3–38.

BARTH, F. G. 1985. Insects and flowers: The biology of a partnership. Princeton University Press, Princeton, New Jersey.

BARRIÁ, A. 1996. Incendio penetró bosque nativo en Juan Fernández. El Mercurio, 22 February.

BERRY, P. E. 1982. The systematics and evolution of *Fuchsia* Sect. *Fuchsia* (Onagraceae). Ann. Mo. Bot. Gard. 69:1–198.

BREMER, K. 1994. Asteraceae: Cladistics and classification. Timber Press, Portland, Oregon.

BRITTON, N. L., and H. A. BROWN. 1913. An illustrated flora of the northern United States and Canada, vols. 2 and 3. Dover Publications, New York.

BROOKE, M. DE L. 1987. The birds of the Juan Fernández Islands, Chile. ICBP Study Report no. 16, Cambridge, England.

CASTILLA, J. C., and D. OLIVA. 1987. Chilean oceanic islands: Description and potentialities. Pages 17–35 *in* J. C. Castilla, ed. Islas oceánicas Chilenas: Conocimiento científico y necesidades de investigaciones. Ediciones Universidad Católica de Chile, Santiago.

CHILTON, C. 1909. The subantarctic islands of New Zealand, vol. 2. Government Printer, Wellington.

CLOS, D. 1846 [1847]. Leguminosas, vol. 2. Pages 46–256 *in* C. Gay. Historia física y política de Chile: Botánica. Paris.

———. 1847 [1848]. Rubiaceae, vol. 3. Pages 177–212 *in* C. Gay. Historia física y política de Chile: Botánica. Paris.

COLWELL, R. K. 1988. Hummingbirds of the Juan Fernández Islands: Natural history, evolution and population status. Ibis 131:548–566.

CRAWFORD, D. J., T. F. STUESSY, M. B. COSNER, D. W. HAINES, D. WIENS, and P. PEÑAILILLO. 1994. *Lactoris fernandeziana* (Lactoridaceae) on the Juan Fernández Islands: Allozyme uniformity and field observations. Conserv. Biol. 8:277–280.

CRUZ, F., J. CRUZ, and J. LAWESSON. 1986. *Lantana camara* L., a threat to native plants and animals. Not. Galapagos 43:10–11.

CUDDIHY, L. W., and C. P. STONE. 1990. Alteration of native Hawaiian vegetation: Effects of humans, their activities and introductions. Coop. Natl. Park Resour. Stud. Unit Univ. Hawai'i, Honolulu.

EKSTAM, U., and N. FORSHED. 1992. Om hävden upphör: Kärlväxter som indikatorarter i ängs- och hagmarker. Naturvårdsverkets Förlag.

FOSBERG, F. R. 1976. *Ipomoea indica* taxonomy: A tangle of morning glories. Bot. Not. 129:35–38.

GAY, C. 1845 [1846]. Historia física y política de Chile: Botánica, vol. 1. Paris.

———. 1849–1852 [1849]. Historia física y política de Chile: Botánica, vol. 5. Paris.

———. 1853 [1854]. Historia física y política de Chile: Botánica, vol. 6. Paris.

GONZÁLEZ-FERRÁN, O. 1987. Geological evolution of Chilean Pacific oceanic islands. Pages 39–54 *in* J. C. Castilla, ed. Islas oceánicas Chilenas: Conocimiento científico y necesidades de investigaciones. Ediciones Universidad Católica de Chile, Santiago.

———. 1995. Volcanes de Chile. Instituto Geografico Militar, Santiago.

GRAY-WILSON, C. 1980. *Impatiens* in Africa. A. A. Balkema, Rotterdam.

GRISEBACH, A. H. R. 1854. Systematische Bemerkungen über die beiden ersten Pflanzensammlungen Philippi's und Lechler's im südlichen Chile und der Maghellans-Strasse. Göttingen.

GROVES, R. H., and F. DI CASTRI, EDS. 1991. Biogeography of Mediterranean invasions. Cambridge University Press, Cambridge.

HEGI, G. 1957. Illustrierte Flora von Mittel-Europa, vol. 3 (1). Carl Hanser, Munich.

HEMSLEY, W. B. 1884. Report on the botany of Juan Fernández, the south-eastern Moluccas, and Admiralty Islands, vol. 1. Pages 1–275 *in* C. W. Thomson and J. Murray, eds. Report on the science results of the voyage of *H.M.S. Challenger.* Botany. London.

HICKMAN, J. C. 1993. The Jepson Manual—Higher plants of California. University of California Press, Berkeley.

JOHOW, F. 1896. Estudios sobre la flora de las Islas de Juan Fernández. Imprenta Cervantes, Santiago.

KUNKEL, G. 1978. Flowering trees in subtropical gardens. Junk Publishers, Boston.

LAWESSON, J. E. 1990. Alien plants in the Galapagos Islands, a summary. Monogr. Syst. Bot. Missouri Bot. Gard. 32:15–20.

LAWESSON, J. E., and L. ORTIZ. 1990. Plantas introducidas en las Islas Galapagos. Monogr. Syst. Bot. Missouri Bot. Gard. 32:201–210.

LID, J. 1985. Norsk, Svensk, Finsk flora. Det Norske Samlaget, Oslo.

LOOSER, G. 1927. La zarzamora (*Rubus ulmifolius* Schott) en Juan Fernández. Rev. Chil. Hist. Nat. 31:85–86.

LÖVE, D., and P. DANSEREAU. 1959. Biosystematic studies on *Xanthium:* Taxonomic appraisal and ecological status. Can. J. Bot. 37:173–208.

MABBERLEY, D. J. 1987. The plantbook. Cambridge University Press, Cambridge.

MARTICORENA, C., and R. RODRÍGUEZ. 1995. Flora de Chile, vol. 1. Universidad de Concepción, Concepción, Chile.

MATTHEI, O. 1986. The genus *Bromus* L. (Poaceae) in Chile. Gayana Bot. 43:47–110.

———. 1995. Manual de las Malezas que crecen en Chile. Published by author, Santiago.

MATTHEI, O., C. MARTICORENA, and T. F. STUESSY. 1993. La flora adventicia del archipiélago de Juan Fernández. Gayana Bot. 50:69–102.

MOORE, M. M. 1983. Flora of Tierra del Fuego. Anthony Nelson, England.

NAUDIN, C. V. 1845 [1846]. Cariofileas, vol. 1. Pages 250–284 *in* C. Gay. Historia física y política de Chile: Botánica. Paris.

NICORA, E. G. 1978. Gramineae. Vol. 3 *in* M. N. Correa, ed. Flora Patagónica. Colección Científica INTA, Buenos Aires, Argentina.

PEDLEY, L. 1986. Derivation and dispersal of *Acacia* (Leguminosae), with particular reference to Australia, and the recognition of *Senegalia* and *Racosperma*. Bot. J. Linn. Soc. 92:219–284.

———. 1987. *Racosperma* Martius (Leguminosae: Mimosoideae) in Queensland: A checklist. Austrobaileya 2:344–357.

PRÉVOST, A. 1753. Continuation de l'histoire générale des voyage de toutes les relations de voyages, vol. 11. Paris.

RICE, E. L. 1984. Allelopathy. Academic Press, New York.

RINGROSE, B. 1685. Bucaniers of America, vol. 2. Ed. 2. London.

SANDERS, R. W., T. F. STUESSY, and C. MARTICORENA. 1982. Recent changes in the flora of the Juan Fernández Islands. Taxon 31:284–289.

SCHLATTER, R. P. 1987. Status and knowledge of birds on Chilean far offshore islands. Pages 273–285 *in* J. C. Castilla, ed. Islas oceánicas Chilenas: Conocimiento científico y necesidades de investigaciones. Ediciones Universidad Católica de Chile, Santiago.

SKOTTSBERG, C. 1910. Juan Fernandez-öarnas sandelträud. Svensk. Bot. Tidskr. 4:167–173.

———. 1921. The phanerogams of the Juan Fernandez Islands. Almqvist and Wiksells, Uppsala.

———. 1951. A supplement to the pteridophytes and phanerogams of Juan Fernández and Easter Island. The natural history of Juan Fernández Islands and Easter Island 2:763–792. Almqvist and Wiksells, Uppsala.

———. 1953. The vegetation of the Juan Fernández Islands. The natural history of Juan Fernández and Easter Island 2:793–960.

SMITH, C. W. 1985. Impacts of alien plants on Hawai'i's native biota. Pages 180–250 *in* C. P. Stone and J. M. Scott, eds. Hawai'i's terrestrial ecosystems: Preservation and management. Coop. Natl. Park Resour. Stud. Unit Univ. Hawai'i, Honolulu.

———. 1989. Non-native plants. Pages 60–69 *in* C. P. Stone and D. B. Stone, eds. Conservation biology in Hawai'i. Coop. Natl. Park Resour. Stud. Unit Univ. Hawai'i, Honolulu.

———. 1990. Weed management in Hawai'i's national parks. Monogr. Syst. Bot. Missouri Bot. Gard. 32:223–234.

SÖDERSTRÖM, P. 1993. Ängs- och hagmarker i Uppsala län: Allmän del. Länstyrelsen, Uppsala.

STUESSY, T. F. 1995. Juan Fernández Islands—Chile, vol. 3. Pages 565–568 *in* S. D. Davis, V. H. Heywood, and A. C. Hamilton, eds. Centres of plant diversity: A guide and strategy for their conservation. WWF, IUCN, Cambridge.

STUESSY, T. F., K. A. FOLAND, J. F. SUTTER, R. W. SANDERS, and M. SILVA O. 1984. Botanical and geological significance of potassium-argon dates from the Juan Fernández Islands. Science (Washington, D.C.) 225:49–51.

STUESSY, T. F., D. J. CRAWFORD, and C. MARTICORENA. 1990. Patterns of phylogeny in the endemic vascular flora of the Juan Fernandez Islands, Chile. Syst. Bot. 15:338–346.

STUESSY, T. F., C. MARTICORENA, R. RODRIGUEZ, D. J. CRAWFORD, and M. SILVA O. 1992. Endemism in the vascular flora of the Juan Fernandez Islands. Aliso 13:297–307.

STUESSY, T. F., U. SWENSON, D. J. CRAWFORD, and M. SILVA O. 1997. Plant conservation in the Juan Fernández archipelago. Aliso (in press).

THUNBERG, C. P. 1784. Flora Japonica sisten plantas insularum Japonicarum. Lipsiae [1975, Facsimile of the first edition, Oriole Editions, New York].

TORRES, D., and A. AGUAYO. 1971. Algunas observaciones sobre la fauna del archipiélago de Juan Fernández. Bol. Univ. Chile 112:26–37.

TUTIN, T. G., V. H. HEYWOOD, N. A. BURGES, D. H. VALENTINE, S. M. WALTERS, and D. A. WEBB, EDS. 1964. Flora Europaea, vol. 1. Cambridge University Press, London.

———. 1968. Flora Europaea, vol. 2. Cambridge University Press, London.

WAGNER, W. L., D. R. HERBST, and S. H. SOHMER. 1990. Manual of the flowering plants of Hawai'i, vols. 1 and 2. University of Hawai'i Press and Bishop Museum Press, Honolulu.

WEBB, C. J., W. R. SYKES, and P. J. GARNOCK-JONES. 1988. Flora of New Zealand, vol. 4. Botany Division, Christchurch.

WESTER, L. 1991. Invasions and extinctions on Masatierra (Juan Fernández Islands): A review of early historical evidence. J. Hist. Geogr. 17:18–34.

WILBUR, R. L. 1963. The leguminous plants of North Carolina. Agricultural Experiment Station, North Carolina.

WOODWARD, R. L. 1969. Robinson Crusoe's island: A history of the Juan Fernández Islands. University of North Carolina Press, Chapel Hill.

## APPENDIX

Known flora of introduced and/or adventitious species to the Juan Fernández Islands with assessment of threat to the native vegetation: (1) noxious, (2) serious, (3) moderate, and (4) harmless. Plants reported in this paper are marked with asterisks (*). Families (gymnosperms, dicotyledons, and monocotyledons, respectively) are in alphabetical order. MT, Masatierra; MF, Masafuera; SC, Santa Clara.

Cupressaceae: *Cupressus goveniana* Gordon, (2), *MT; *C. macnabiana* A. Murray, (2) ,*MT, *MF.

Pinaceae: *Pinus radiata* D. Don, (2), *MT.

Aizoaceae:*Carpobrotus edulis* (L.) N.E. Br., (3), *MT, *MF; *Tetragonia tetragonioides* (Pallas) Kuntze, (4), MT, MF, SC.

Amaranthaceae: *Amaranthus deflexus* L., (3), MT, MF; *A. hybridus* L., (3), MT.

Apiaceae: *Ammi visnaga* (L.) Lam., (3), MT; *Anethum graveolens* L., (4), MF; *Apium australe* Thouars, (4), *MT; *A. chilense* Hook. & Arn., (4), MT; *A. graveolens* L., (4), MT; *Ciclospermum leptophyllum* (Pers.) Sprague, (3), MT; *Conium maculatum* L., (1), MT, MF; *Coriandrum sativum* L., (4), MT; *Daucus montanus* Humb. & Bonpl. ex Sprengel, (4), MT; *Foeniculum vulgare* Miller, (3), MT; *Petroselinum crispum* (Miller) A.W. Hill, (4), MT, MF; *Sanicula crassicaulis* Poepp. ex DC., (4), MT; *Torilis nodosa* (L.) Gaertner, (3), MT.

Apocynaceae: *Vinca major* L., (4), MT.

Asteraceae: *Amblyopappus pusillus* Hook. & Arn., (4), MT, SC; *Anthemis cotula* L., (2), MT; *Artemisia absinthium* L., (4), MT; *Bahia ambrosioides* Lag., (4), MF; *Bidens pilosa* L., (2), MT, MF; *Calendula officinalis* L., (3), MT; *Carthamus lanatus* L., (3), MT, MF; *Centaurea melitensis* L., (3), MT, MF, SC; *Chamomilla recutita* (L.) Rauschert, (3), MT; *Chrysanthemum coronarium* L., (2), MT; *Cichorium intybus* L., (3), MT, MF; *Cirsium vulgare* (Savi) Ten., (3), MF; *Conyza bonariensis* (L.) Cronq., (3), MT, MF, SC; *Cotula australis* (Sieber ex Sprengel) Hook.f., (3), MT, MF; *C. coronopifolia* L., (4), MT; *Crepis capillaris* (L.) Wallr., (4), MT; *Cynara cardunculus* L., (3), MT, MF; *Delairea odorata* Lem,. (2), MT; *Galinsoga parviflora* Cav., (3), MT, MF; *Gamochaeta spicata* (Lam.) Cabrera, (3), MT, MF; *G. stachydifolia* (Lam.) Cabrera, (4), MT, MF, SC; *Gnaphalium aldunateoides* Remy, (3), MF; *Hypochaeris glabra* L., (4), MT, MF, SC; *H. pumila* Phil., (4), MT, MF; *H. radicata* L., (3), MT, MF; *Lapsana communis* L., (4), MT, MF; *Madia sativa* Molina, (4), *MF; *Micropsis nana* DC., (4), MT; *Pseudognaphalium cheiranthifolium* (Lam.) Hilliard & B.L. Burtt, (3), MT, MF, SC; *Senecio vulgaris* L., (3), MT, MF; *Silybum marianum* (L.) Gaertner, (2), MT, MF, SC; *Solidago chilensis* Meyen, (4), MT; *Sonchus oleraceus* L., (3), MT, MF, SC; *S. tenerrimus* L., (3), MT, MF, SC; *Xanthium spinosum* L., (3), MT, *MF.

Balsaminaceae: *Impatiens sodenii* Engl., (4), *MT.

Boraginaceae: *Cynoglossum creticum* Miller, (3), MT; *Myosotis laxa* Lehm., (4), *MT; *M. sylvatica* Hoffm., (3), *MT.

Brassicaceae: *Brassica napus* L., (3), MT, MF, SC; *B. nigra* (L.), W.D.J. Koch, (3), MT; *B. rapa* L., (3), MT; *Hirschfeldia incana* (L.) Lagr.-Fossat, (3), MT; *Lepidium bonariense* L., (3), MT; *Matthiola incana* (L.) R. Br., (3), MT, MF, SC; *Raphanus sativus* L., (2), MT, MF; *Rorippa nasturtium-aquaticum* (L.) Hayek, (3), MT, MF; *Sisymbrium officinale* (L.) Scop., (2), MT.

Callitrichaceae: *Callitriche lechleri* (Hegelm.) Fassett, (4), MT.

Campanulaceae: *Lobelia tupa* L., (4), MT.

Caprifoliaceae: *Lonicera japonica* Thunb., (1), *MT; *Sambucus mexicana* C. Presl, (3), *MT.

Caryophyllaceae: *Cerastium fontanum* Baumg. ssp. *vulgare* (Hertman) Greuter & Burdet, (3), MF; *C. glomeratum* Thuill., (3), MT, MF; *Paronychia franciscana* Eastw., (4), MT; *Polycarpon tetraphyllum* (L.) L., (3), MT, MF; *Sagina chilensis* Naudin, (4), MF; *Silene gallica* L., (3), MT, MF, SC; *Spergularia rubra* (L.) J. Presl & C. Presl, (3), *MT; *Stellaria chilensis* Pedersen, (4), MT; *S. media* (L.) Villars, (3), MT, MF.

Chenopodiaceae: *Beta vulgaris* L. ssp. *maritima* (L.) Arcang., (4), *MT; *Chenopodium ambrosioides* L., (3), MT, MF; *C. multifidum* L., (3), MT, MF; *C. murale* L., (3), MT, MF, SC; *C. sanctae-clarae* Johow, (4), *MT.

Convolvulaceae: *Convolvulus arvensis* L., (3), MT, MF; *Ipomoea indica* (Burm.) Merr., (1), *MT.

Dipsacaceae: *Dipsacus sativus* (L.) Honck., (4), MT; *Scabiosa atropurpurea* L., (3), MT.

Elaeocarpaceae: *Aristotelia chilensis* (Molina) Stuntz, (1), MT, MF; *Crinodendron patagua* Molina, (3), MT.

Euphorbiaceae: *Euphorbia lathyris* L., (3), MT; *E. peplus* L., (3), MT, MF; *Ricinus communis* L., (3), MT, MF.

Fabaceae: *Albizia lophantha* Link, (2), MT; *Medicago arabica* (L.) Hudson, (4), MT, *MF; *M. lupulina* L., (3), MT; *M. polymorpha* L., (3), MT, MF, SC; *M. sativa* L., (4), MT, MF; *Melilotus indicus* (L.) All., (3), MT, MF, SC; *Racosperma dealbatum* (Link) Pedley, (2), MT; *R. melanoxylon* (R. Br.) C. Mart., (2), *MT, *MF; *Teline monspessulana* (L.) K. Kock, (1), MT; *Trifolium dubium* Sibth., (4), *MF; *T. pratense* L., (3), MT; *T. repens* L., (4), MT, MF.

Fagaceae: *Castanea sativa* L., (4), *MT.

Gentianaceae: *Centaurium cachanlahuen* (Molina) B.L. Rob., (4), MT.

Geraniaceae: *Erodium cicutarium* (L.) L'Hér. ex Aiton, (3), MT, MF, SC; *Geranium core-core* Steud., (3), MT, MF;

*G. dissectum* L., (4), MT; *G. robertianum* L., (4), MT; *Pelargonium* × *asperum* Willd., (4), *MT.

Hypericaceae: *Hypericum perforatum* L., (3), MT, MF.

Lamiaceae: *Marrubium vulgare* L., (4), MT, MF; *Melissa officinalis* L., (4), MT, MF; *Mentha aquatica* L., (4), MT; *M. pulegium* L., (3), MT, MF; *Origanum majorana* L., (4), MF; *Prunella vulgaris* L., (2), MT; *Stachys arvensis* L., (4), MT.

Lardizabalaceae: *Lardizabala biternata* Ruiz & Pavón, (4), MT.

Linaceae: *Linum usitatissimum* L., (3), MT.

Loranthaceae: *Tristerix corymbosus* (L.) Kuijt, (3), MT.

Lythraceae: *Lythrum hyssopifolia* L., (3), MT.

Malvaceae: *Anoda cristata* (L.) Schldl., (3), MT; *Lavatera arborea* L., (3), *MT; *Malva nicaensis* All., (3), MT; *M. parviflora* L., (3), MT, SC; *Modiola caroliniana* (L.) G. Don., (3), MT, MF.

Moraceae: *Ficus carica* L., (4), *MT, *MF.

Myrtaceae: *Eucalyptus globulus* Labill., (1), *MT, *MF; *Ugni molinae* Turcz., (1), MT, MF.

Nyctaginaceae: *Mirabilis jalapa* L., (4), *MT.

Onagraceae: *Fuchsia magellanica* Lam., (4), *MT; *Oenothera affinis* Cambess., (3), MT, MF; *O. picensis* Phil., (4), MT, MF; *O. rosea* L'Hér. ex Aiton, (3), MT, MF.

Oxalidaceae: *Oxalis corniculata* L., (3), MT, MF; *O. micrantha* Bertero ex Colla, (3), MT, MF.

Papaveraceae: *Fumaria capreolata* L., (3), MT; *Papaver somniferum* L., (2), MT.

Plantaginaceae: *Plantago lanceolata* L., (4), MT, MF; *P. major* L., (3), MT.

Polemoniaceae: *Gilia valdiviensis* Griseb., (4), MF; *Microsteris gracilis* (Douglas ex Hook.) Greene, (4), MT.

Polygonaceae: *Polygonum aviculare* L., (3), MT, MF; *P. hydropiperoides* Michaux, (3), MT; *P. lapathifolium* L., (3), MT; *Rumex acetosella* L., (1), MT, MF; *R. conglomeratus* Murray, (2), MT, MF; *R. crispus* L., (2), MT, MF, SC; *R. pulcher* L., (3), MT, MF, SC.

Portulacaceae: *Calandrinia monandra* (Ruiz & Pavón) DC., (4), MF; *Portulaca oleracea* L., (3), MF.

Primulaceae: *Anagallis arvensis* L., (3), MT, MF; *A. minima* (L.) E.H. Krause, (4), MF.

Ranunculaceae: *Anemone decapetala* Ard., (3), MT; *Ranunculus muricatus* L., (3), MT.

Rosaceae: *Acaena argentea* Ruiz & Pavón, (1), MT, MF; *A. ovalifolia* Ruiz & Pavón, (1), MT, MF; *Fragaria chiloensis* (L.) Duchesne, (4), MT, MF; *Prunus persica* (L.) Batsch, (4), *MF; *Rubus ulmifolius* Schott, (1), MT, MF.

Rubiaceae: *Galium aparine* L., (3), *MT, MF.

Rutaceae: *Ruta chalepensis* L., (3), MT, MF.

Scrophulariaceae: *Digitalis purpurea* L., (3), MF; *Kickxia elatine* (L.) Dumort., (4), MF; *Verbascum thapsus* L., (4), MT; *V. virgatum* Stokes, (3), MT, MF; *Veronica anagallis-aquatica* L., (3), MT; *V. arvensis* L., (4), MT; *V. persica* Poiret, (4), MT.

Solanaceae: *Cestrum parqui* L'Hér., (3), MT, MF; *Datura stramonium* L., (3), MT; *Nicotiana tabacum* L., (4), MT; *Physalis peruviana* L., (4), MT, MF; *Solanum argenteum* Dunal ex Poiret, (3), MT, MF; *S. furcatum* Dunal ex Poiret, (4), MT, MF, SC; *S. marginatum* L.f., (3), MT; *S. pseudocapsicum* L., (4), *MT; *S. tuberosum* L., (4), MT.

Tropaeolaceae: *Tropaeolum majus* L., (2), MT.

Urticaceae: *Urtica urens* L., (4), MT, SC.

Valerianaceae: *Centranthus ruber* (L.) DC., (4), *MT.

Verbenaceae: *Lantana camara* L., (1), *MT; *Verbena litoralis* Kunth, (2), MT, MF.

Araceae: *Zantedeschia aethiopica* (L.) Spreng., (3), *MT, *MF.

Iridaceae: *Crocosmia* × *crocosmiiflora* (Lemoine ex Burb. & Dean) N.E. Br., (3), MT.

Juncaceae: *Juncus bufonius* L., (4), *MF; *Juncus capillaceus* Lam., (4), *MT.

Poaceae: *Agrostis stolonifera* L., (3), MT, MF; *Aira caryophyllea* L., (3), MT, MF; *A. praecox* L., (3), MT, MF; *Anthoxanthum odoratum* L., (1), MT, MF; *Avena barbata* Pott ex Link, (2), MT, MF, SC; *Briza maxima* L., (2), MT; *B. minor* L., (3), MT, MF; *Bromus catharticus* Vahl, (4), *MT, *MF; *B. diandrus* Roth, (3), MF; *B. hordeaceus* L., (3), MT, SC; *B. lithobius* Trin., (4), MT, MF; *B. stamineus* E. Desv., (3), MT, MF; *Chascolytrum subaristatum* (Lam.) Desv., (4), MT; *Cynosurus echinatus* L., (4), MF; *Dactylis glomerata* L., (2), *MT; *Danthonia chilensis* E. Desv. var. *chilensis,* (4), *MT; *Digitaria sanguinalis* (L.) Scop., (3), MT; *Gastridium ventricosum* (Gouan) Schinz & Thell., (3), MT; *Hordeum murinum* L. ssp. *murinum,* (3), MT, MF, SC; *H. secalinum* Schreber, (3), MT; *Lolium multiflorum* Lam., (2), MT, MF; *L. perenne* L., (2), *MT; *Paspalum dasypleurum* Kunze ex E. Desv., (4), *MT; *P. distichum* L., (4), MT; *Phalaris amethystina* Trin., (3), MT; *P. angusta* Ness ex Trin., (3), MT; *Poa annua* L., (3), MT, MF; *P. pratensis* L., (3), MF; *Polypogon australis* Brongn., (3), MT, MF; *Setaria parviflora* (Poiret) Kerguélen, (3), MT, *MF; *S. viridis* (L.) P. Beauv., (3), MT; *Vulpia bromoides* (L.) Gray, (3), MT, MF; *V. muralis* (Kunth) Nees, (3), MT; *V. myuros* (L.) C.C. Gmelin var. *megalura* (Nutt.) Auq., (3), MT, MF.